

## New Results on the Statistical Properties of the Large Eddies in Homogeneous Turbulence

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New results on the statistical properties of the large eddies in homogeneous turbulence are described.<sup>1</sup> It is shown that with a weak and plausible hypothesis on the forces generating the turbulence, the energy spectrum function  $E(k)$  is proportion to  $k^2$  for small  $k$ , and that the coefficient of proportionality is a dynamical invariant of the turbulence. The results of Batchelor and Proudman on the large scale structure and the well known  $k^4$  dependence are obtained by taking the invariant to have the value zero, but there is no obvious dynamical or kinematical reason why the invariant should vanish, and in general its value will depend upon the mechanism of the turbulent production. For isotropic turbulence, the longitudinal correlation function  $f(r)$  is found to behave like  $r^{-3}$  for large  $r$ , which supports the old speculation by many workers that the Loitsianskii invariant does not converge.

<sup>1</sup> P. G. Saffman, *J. Fluid Mech.* (to be published).

## Higher-Order Correlations in a Turbulent Field

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Higher-order time-correlations up to the eighth order were measured at the initial stage of decay in a turbulent field downstream of a grid using high-speed computing techniques. The results were obtained using samples of 160 020 digitized data recorded at time intervals of 1/12 800 sec during time periods of approximately 12.5 sec. Particular attention is given to the deviations of the probability-density distributions of turbulent velocities from Gaussianity. Comparison is made between the measured correlations and the higher-order correlation curves corresponding to a Gaussian probability density distribution. It is demonstrated that the even-order correlations are not sensitive to the departures from Gaussianity and that they are quite small even for the eighth-order correlation. Non-Gaussian probability distributions are proposed which correspond considerably better to experimental reality in that they not only account for the odd-order correlations but also agree better with the results for the even-order correlations. Several relations between correlation coefficients of different orders are obtained for the non-Gaussian probability distributions and confirmed by comparison with the measured correlations, skewnesses, and flatnesses.<sup>1</sup>

The digital methods are being extended to the study of three-point correlations both in time and space. Some preliminary results for the time-correlation  $u'(t)u'(t+h_1)u'(t+h_2)/[u'^2(t)]^3$  are presented which demonstrate the feasibility of such measurements.

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<sup>1</sup> The above results are included in the paper: F. N. Frenkiel and P. S. Klebanoff, *Phys. Fluids* **10**, 507 (1967).